University of Bahrain
College of Information Technology
Department of Computer Science
ITCS 312 Formal Languages & Automata Theory
Final Examination
1st Semester 2003-2004

Time: 2Hrs **Max. Marks: 76**

Q 1.

a) **(4 marks)** Define any **two** of the following
1. Language accepted by an npda, $M=(Q, \Sigma, \Gamma, \delta, q0, z, F)$
2. Turing Machine
3. Extended Transition function in nfa.

b) **(4 marks)** Are the following true? Give reasons
1. An npda can recognize more languages than a dfa.
2. Turing machines may not halt.

c) **(2 marks)** Give a simple description of the language generated by
$S \rightarrow aA|\lambda$
$A \rightarrow bS$

d) **(4 marks)** The transition function of a Turing machine is given as
$\delta(q_0, a)=(q_0, a, R)$
$\delta(q_0, \square)=(q_1, \square, R)$
$F=\{q_1\}$
Find the language accepted.

e) **(5 marks)** What language is accepted by the npda $M=(\{q_0, q_f\},\{a,b\},\{1, 2, z\}, \delta, q_0, z, \{q_f\})$ with
$\delta(q_0, a, z)=\{(q_0,1z)\}$
$\delta(q_0, a, 1)=\{(q_0, 1)\}$
$\delta(q_0, b, 1)=\{(q_0, 2)\}$
$\delta(q_0, a, 2)=\{(q_0, 2)\}$
$\delta(q_0, \lambda, 2)=\{(q_f, 2)\}$

f) **(9 marks)** Write regular expression, draw an nfa, and a dfa, for the language having set of all strings starting with ab over $\Sigma=\{a, b\}$. The dfa can be found directly or by converting the nfa into dfa.

g) **(10 marks)** Find right-linear and left- linear grammar for
$L=\{a^n b^m : n \geq 2, m \geq 3\}$

h) **(4 marks)** The Nand of two languages is
Nand $(L_1, L_2) = \{\omega \notin L_1 \text{ or } \omega \notin L_2\}$.

Using the closure properties of regular languages, show that the family of regular languages is closed under Nand operation.

i) **(6 marks)** Consider the grammar

$S \rightarrow S \vee S \mid F$

$T \rightarrow T \wedge S \mid T$

$F \rightarrow \sim F \mid (S) \mid \text{true} \mid \text{false}$

1. Construct a derivation tree for $\sim(\text{true} \vee \text{false})$
2. Is the grammar ambiguous? Why?

j) **(4 marks)** Design an npda to accept L(G) where

G: $S \rightarrow c \mid cS \mid cAB$

$A \rightarrow b \mid bSB \mid bA$

$B \rightarrow a \mid aSB \mid aB$

Q 2. (12 marks) Simplify the following grammar

$S \rightarrow a \mid aA \mid BA \mid C$

$A \rightarrow aB \mid \lambda$

$B \rightarrow Aa \mid \lambda$

$C \rightarrow cCD$

$D \rightarrow d$

$E \rightarrow A \mid \lambda$

Q 3. (12 marks) Consider $L = \{a^n b^{2n+1} : n > 0\}$.

a) Give a CFG to generate L.

b) Design an npda to accept L.